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Hypotheses related to procedures permitting students to branch at their own option were tested. The first hypothesis was that a fixed-sequence program would be less effective than the same items cast as statements in textbook format through which the student could skip at his own option. The second hypothesis was that performance on a program which allowed the student to review previous materials, one item at a time, would also exceed performance on a fixed-sequence program.

Subjects from junior and senior high school classes were randomly grouped. The fixed-sequence group was given, in a fixed-sequence, 61 teaching items on cards that were in a loose-leaf binder. They were to give a covert response to each item and compare answers with the correct answer. The back-branching group was given the same items in a fixed-sequence; the group was permitted to review earlier material by looking back, one item at a time. The textbook group was given a typewritten text of the same materials in statement and paragraph form. There were no limitations to the manner of use. Mastery of the topics was tested with 24 free-response and 24 multiple-choice questions. Half of the questions were similar to the training materials and half were on situations which required application or transfer of learning.

Comparison of the scores for the textbook and the fixed-sequence groups confirmed that the textbook method, which permitted freedom in branching, was better. The hypothesis that the back-branching method would be superior to the fixed-sequence method was not confirmed.

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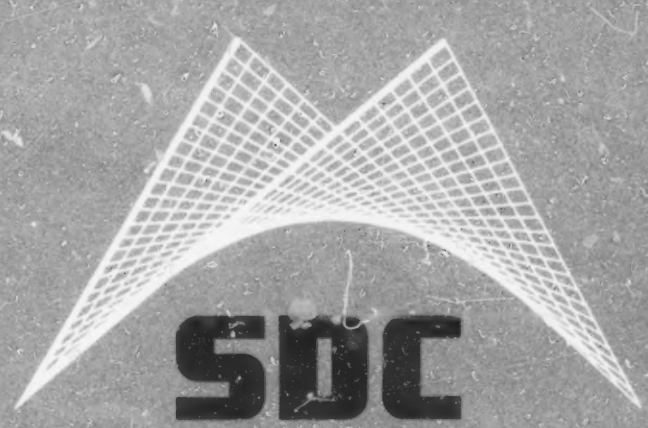


SP-213

# A Comparison of Fixed Sequence and Optional Branching Auto-Instructional Methods

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19 November 1960

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Ralph J. Melaragno, Harry F. Silberman, John E. Coulson

November 19, 1960

SYSTEM DEVELOPMENT CORPORATION, SANTA MONICA, CALIFORNIA

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# A COMPARISON OF FIXED SEQUENCE AND OPTIONAL BRANCHING AUTO-INSTRUCTIONAL METHODS

Ralph J. Melaragno, Harry F. Silberman, John E. Coulson

Although many varieties of teaching machines exist today, two basic auto-instructional methods may be identified. One displays a fixed sequence of teaching items, requiring all Ss to see all items in the sequence. The other method uses a variable sequence of items, allowing the student to branch to review materials when needed and to skip ahead when his performance dictates such a skip. Coulson and Silberman (1960), using a manually operated machine, made comparisons between a fixed sequence of items and another condition in which some of the items in the sequence were skipped by students who made no errors. In that study, the wishes of the student were not considered in determining whether he was branched back to preceding items or skipped ahead to subsequent materials. The branching depended entirely on the errors made on the items.

The purpose of the present study was to test two hypotheses related to procedures permitting the student to branch at his own option. The first hypothesis was that a fixed-sequence program would be less effective than the same items cast as statements in textbook format through which the student could skip at his own option. The ease of reviewing and the facility for skipping ahead with the textbook format are the bases for this hypothesis. The second hypothesis was that performance on a program which allowed the

student to review previous materials, one item at a time, would also exceed performance on a fixed-sequence program.

## METHOD

### Subjects

Fifty-one students (20 males and 31 females) were selected from five high schools in Los Angeles County. Ss were obtained from junior and senior classes of the five schools. Random assignment of Ss to three treatment groups resulted in seven males and ten females being assigned to each of two groups and six males and eleven females being assigned to the third group. Ss were pre-tested with the Henmon-Nelson Test of Mental Ability (Form A, Grades 9-12).

### Materials

Sixty-one multiple-choice teaching items on some topics in logic were prepared and given a preliminary trial in a number of secondary schools. Items were revised, typed on 5x8 cards, and mounted in loose-leaf binders for the experiment. The number of items for each topic and the number of test questions included in a criterion post-test are shown in Table 1. The textbook materials consisted of the same information contained in the teaching items but cast in statement form and organized into paragraphs.

### Procedure

Three instructional methods were used for the three groups. The first group, designated "fixed-sequence," (Henmon-Nelson mean = 114.1) received the 61 teaching items in a fixed sequence. The second group, designated "back-branching," (Henmon-Nelson mean = 113.1) received the same 61 teaching items

TABLE 1

Number of teaching items and test questions for each topic of the logic lesson

| Topic | Teaching Items | Test Questions |
|---|---|---|
| Simple and Compound Statements | 2 | 1 |
| Using Symbols to Represent Statements | 2 | 2 |
| Connectives: | | |
| or | 5 | 4 |
| not | 3 | 2 |
| if . . . then . . . | 3 | 5 |
| Combination of Connectives | 2 | 2 |
| Introduction to Arguments | 12 | 4 |
| Arguments: | | |
| Valid disjunctive | 9 | 7 |
| Disjunctive fallacy | 9 | 11 |
| Conditional argument affirming the antecedent | 14 | 10 |
| Total | 61 | 48 |

but were permitted to review preceding items by backing up one item-card at a time. The third group, designated "textbook," (Henmon-Nelson mean = 111.3) received a typewritten text consisting of the same materials presented to the other two groups, except that the teaching items were cast into statement form and organized into paragraphs according to the topics covered.

Ss were run one at a time in an air-conditioned cubicle with one-way glass windows. Ss were instructed to take as much time as they needed to cover the material in the lesson and were also told that an examination on the material would be given them immediately after they had completed their study session.

Ss in the fixed-sequence group were instructed to give a covert response to each item in turn, and to compare their answer with the correct answer, which was inscribed on the back of the card. Ss in this group were further instructed not to turn back to preceding items. Ss in the back-branching group were given the same instructions, except that they were encouraged to review earlier material by looking back one item at a time. Back-branching Ss were told not to skip past any items, so that they would view each item in the sequence at least once. (For example, an S may progress through items 1, 2, 3, 4, and 5, then back up to item 3 before going on to item 6. The resulting sequence would be: 1, 2, 3, 4, 5, 4, 3, 6.) Ss in the textbook group were simply told to study the material in whatever manner they chose. All Ss were observed through the one-way windows to insure that they were following directions carefully and, additionally, to check on whether Ss in the back-branching group exercised the branching capability.

Mastery of the topics covered in the teaching session was tested with 24 free-response and 24 multiple-choice test questions. Half of the questions were similar to the actual training materials and half consisted of situations which required application or transfer of learning. Split-half reliability of the post-test was .93 (after Spearman-Brown correction).

The test was administered immediately after the training session. The results on the criterion post-test, and on training time, are shown in Table 2.

RESULTS

Table 2

Criterion post-test scores and training times

| | SCORES | | | TIME (in minutes) | |
|---|---|---|---|---|---|
| | N | Mean | SD | Mean | SD |
| Fixed-Sequence | 17 | 28.4 | 8.7 | 32.8 | 10.7 |
| Back-Branch | 17 | 30.8 | 9.7 | 31.8 | 9.6 |
| Textbook | 17 | 33.7 | 6.4 | 31.5 | 11.1 |

Difference between scores for the fixed-sequence and the back-branching groups was not significant ($t = .80$, $p > .10$). Difference between scores for the fixed sequence and the textbook groups was significant ($t = 1.79$, $p < .05$).

Correlations of aptitude, training time, and criterion scores for all three groups are given in Table 3.

Table 3

Correlations of aptitude, time, and score

| | Fixed Sequence | Back Branching | Textbook |
|---|---|---|---|
| Apt vs Score | .45 | .39 | .67** |
| Apt vs Time | - .52* | -..45 | - .31 |
| Time vs Score | - .14 | .03 | - .04 |

*$p = .05$ **$p = .01$

## DISCUSSION

Comparison of the criterion post-test scores for the textbook and the fixed-sequence groups confirms the hypothesis that the textbook method, which permits the freedom to branch, is superior, while the second hypothesis, that the back-branching method would be superior to the fixed-sequence method, was not confirmed.

Of particular note in the table of correlations (Table 3) is the significant aptitude vs. score correlation in the textbook group and the absence of a similar significant correlation for these two variables in the back-branching group. Low aptitude Ss in the back-branching group evidently were assisted by the review feature and were able to master the material along with the high aptitude Ss. The textbook method, on the other hand, was most useful for the brighter Ss, who probably possess study skills which allow them to outstrip their lower aptitude fellows using the same method.

Over-all, the results of this study indicate that the relationship between flexibility of materials and rate of learning favors the flexible materials over the fixed sequence. Certain implications for further exploration are evident when this study is compared with those by Holland (1960) and Cook and Spitzer (1960), which contain features similar to it.

Holland also used three instructional groups. Members of the first group were trained with items in conventional format, with confirmation of the correct answer following S's overt response using the Skinner teaching machine (Skinner, 1958). This is comparable to the fixed-sequence group of the present study,

except that Ss in the present study were instructed to make a covert response to each item. In Holland's second group, Ss were given the same items as the first group, but received no confirmation following their response. A third group received materials consisting of the same items as appeared on the machine disks, but cast as factual statements. This is comparable to the textbook group in this study.

Holland's first and second programs required overt responses. The third program acted as a control, or no-response, condition. Results showed performance on the first two programs to be superior to the control group. No difference was obtained between the first two conditions. Holland interpreted his results as lending support for the auto-instructional principle that an overt response has to occur for efficient learning. If branching has more effect on learning than the requirement of overt responses, one would have expected performance on Holland's third program to exceed performance on the first two.

Cook and Spitzer (1960) reported results of a study which conflict with those described by Holland. Cook and Spitzer concluded from their results that overt responses interfere with learning and that the prompting procedure (statements) is superior to confirmation because of the enforced delay between stimulus and response terms in the confirmation method.

The present study lends support to the prompting side of the prompting-confirming question. The results of this study corroborate the superiority of prompting over confirmation when no overt response is required. The basis for this superiority, however, is attributed to the free option the student has in selecting a sequence of material suitable for his needs.

It remains for further research to compare the response requirement, S-R delay, and optional branching explanations of these recent findings.

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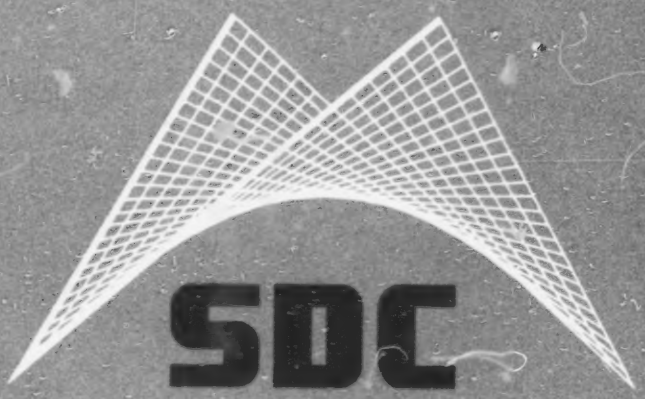


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